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54 Packaging glass fibre batts.

57 For applying a covering to glass fibre insulation batts, the batts are deposited in succession into a vertically elongate batt stacking space (55) to form a stack (80) of the batts, and upper and lower compression plates (58, 60) each having a concave compression surface, the shape of the compression surfaces corresponding at least substantially to the shapes of convex upper and lower surfaces of the package, are displaced vertically by an amount sufficient to compress the stack with a compression ratio of 6:1 to 11:1. A covering (37, 41) of flexible sheet material is then provided around the compressed stack (80) to maintain the stack in a compressed state. The concave compression make possible a higher compression of the batts than was possible with the flat compression plates used in the prior art, avoiding damage to the batts and promoting satisfactory recovery of the batts when released from their compressed state.

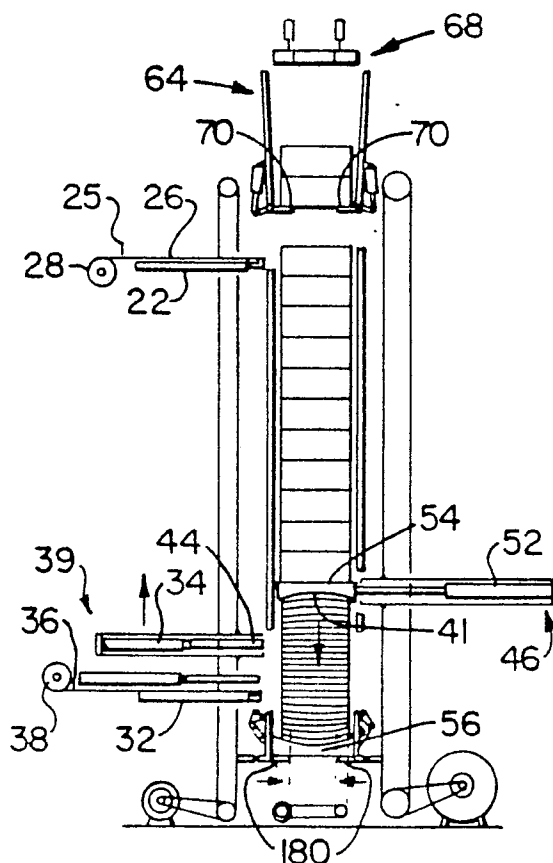


FIG. 4G

The present invention relates to a method of and apparatus for applying a covering to glass fibre batts.

Glass fibre insulation batts are conventionally sold in prepackaged and compressed stacks of batts, which are compressed at compression ratios of between 3:1 and 5:1 and contained in plastic bags, which retain the batts in their compressed state.

Furthermore, for bulk transportation, groups of the bags are often further compressed into bales, providing an overall compression ratio of between 6:1 and 11:1. The second compression of the batts saves money on shipping and storage costs, but at some extra cost in extra packaging material and processing costs.

Hitherto, it has been well known to effect the packaging of such batts by compressing the batts in a stack and by then pushing the compressed stack of batts through a snout into a pre-made bag, the mouth of which is held open by the mouth of the snout through which the compressed batts enter the bag.

This technique is employed, for example, in the apparatuses and methods taught by Canadian Patent No. 952,495, issued August 6, 1974 to Gilles L. Vachon; Canadian Patent No. 1,081,186, issued July 8, 1980 to Theodore E. O'Brien; United States Patent No. 4,099,363, issued July 11, 1978 to Nikolai K. Wistinghausen et al. and United States Patent No. 4,094,130, issued July 13, 1978 to Norman Kelly et al.

More particularly, the aforementioned prior patents each describe an apparatus in which batts are transported downwardly through a batt stacking space on a platen, on which the batts are assembled into a stack by dropping the batts vertically from a batt accumulator mechanism overlying the batt stacking space. When the platen approaches the bottom of a batt stacking space, the platen is withdrawn laterally from the space and recycled to the top of the space, which it reenters and down which it then travels to compress the batts in a compression space. The thus-compressed batts are laterally ejected in their compressed state through a snout into a bag, as described above.

From the aforementioned prior patents, it is also known to firstly compress a first portion of a stack, and thereafter to compress the remainder of the stack and to unite the compressed first portion and the compressed remainder, in order to reduce the overall height of the apparatus employed for assembling and compressing the stack of the batts, prior to the insertion of the stack in its compressed condition into a bag.

Other patents which disclose the use of snouts through which compressed batts are rammed into bags include United States Patent 4,501,107, issued February 26, 1985 to Tony S. Piotrowski, and United States Patent 4,182,237, issued January 8, 1980 to Theodore E. O'Brien.

In these prior batt compression and bagging apparatuses, the stacks of batts are compressed between flat compression surfaces prior to being ejected through the snout. The batts expand somewhat within their bag after leaving the snout and consequently the finished bag of batts assumes a configuration having slightly convex top and bottom faces, the batts being subjected to an initial compression between the compression plates and, subsequently, portions of the batts being subjected to additional compression or slight expansion at the bagging stage.

This additional compression of the batts and the forcing of the batts through the snout by the ram into the bag, and also the expansion of the batts within the bag, as described in greater detail below, frequently result in damage to the batts.

Furthermore, the compression of the batts is necessarily limited in practice, and in accordance with the numbers and sizes of the batts, in order to ensure that when the batts are eventually released from their package at their point of use and thus allowed to expand from their compressed state, the batts can expand sufficiently to regain or recover sufficient of their original thickness, i.e. their thickness prior to compression.

Consequently, the compression ratio employed for the compression of the batts between the compression plates has hitherto been limited in order to avoid or at least reduce damage to the batts and to permit sufficient recovery of the batts when they are unpackaged. More particularly, it has hitherto been conventional to provide bags of glass fibre insulation batts in which the batts are compressed with the package compression ratio of 3:1 to 5:1, as indicated above. Consequently, the number of batts which can be accommodated in a bag of a given size is correspondingly limited.

As also mentioned above, the bagged or packaged stacks of batts are further compressed into bales to provide an overall compression ratio of between 6:1 and 11:1, which of course necessitate a separate operation and thus increases costs and processing times.

A further disadvantage of the above-described prior art glass fibre insulation batt packaging or bagging machines was that the throughput of such machines, i.e. the initial bagging of the batts, was restricted to an undesirably low rate. More particularly, it was found in practice that as the throughput of such machines was increased, problems arising from misalignment of the batts in the batt compres-

sion space and from increased vibration, and consequential wear, which occurred as a result of the correspondingly higher speeds of operation of the machines, and thus the reliability of the operation of these machines at these higher speeds, effectively limited the maximum speeds at which the machines could be operated. The need for increased productivity indicated that such speed limitations should be overcome.

It has also previously been proposed to package compressible products in a compressed condition other than by forcing such products through a snout into a bag. For example, United States Patent 3,246,443, issued September 7, 1961 to C.O. Slemmons teaches a method and apparatus for packaging foam cushion material in which the material is compressed in a suitable press comprising a bed and a movable platen 18 with sheets of thermoplastic, air impervious material such as polyethylene, polyvinylchloride, etc. being interposed between the top and bottom of the foam cushion material and the bed and platen. When the press is closed, these sheets are heat sealed to one another around the periphery of the compressed foam cushion material to form a covering retaining the latter in its compressed state. The bed and the movable platen taught by this prior patent are both flat and no information is given with respect to the compression ratios employed.

United States Patent 2,765,838, issued October 9, 1956 to G. H. Brown, teaches apparatus for packaging a group of fibrous mats or batts, made for example of glass fibre, by placing a stack of the fibrous mats upon a first sheet of paper on a conveyor flight supported by a reinforcing plate, placing a further sheet of paper on the top of the stack of fibrous mats and then compressing the stack by downward movement of a platen against the top of the stack, the edge portions of the sheets of paper being folded and adhered together to enclose the compressed stack. Once again, flat surfaces are employed for compressing the product and no information is provided as to the compression ratios employed.

The teachings of the above-mentioned United States Patents 3,246,443 and 2,765,838 do not, however, take into account or counteract the damage which can occur to glass fibre insulation batts when such batts are bagged while in a state of compression which is substantially higher than has conventionally been employed hitherto.

More particularly, it is found in practice that when glass fiber insulation batts are compressed to a substantially higher degree than is usual in the art, and then bagged, not only do the above-de-

scribed batt recovery problems arise but also damage to the batts occurs at the longitudinal edges of the batts as a result of the increased tension in the sheet material of the bag.

Thus, when the batts are compressed to a high degree, bagged and subsequently released from the bagging machine, some expansion of the batts within their bag occurs. This expansion causes the bag material to be tensioned at the top and bottom of the bag, consequently, the batts are able to expand further intermediate their longitudinal edge portions than at their longitudinal edges, into a convex shape at the top and the bottom of the bag, so that the longitudinal edges of the batts are unduly compressed and distorted.

This undesirable and harmful effect arises as a consequence of the use of flat compression surfaces to effect the compression of the batts as taught, for example, in the above-mentioned United States Patents 3,246,443 and 2,765,838.

The inventor has now found that a substantial improvement in the packaging of glass fibre insulation batts is obtained by employing, in place of the flat compression surfaces employed by the prior art, a pair of compression surfaces which are recessed, preferably in a curved manner, so as to at least approximate in a complimentary manner to the convexly curved shapes of the corresponding surfaces of the finished batt package or its bag.

More particularly, it has surprisingly been found that employing these novel recessed compression surfaces to effect the compression of the stack of batts the compression ratio utilized for such compression can be substantially increased, thus correspondingly reducing the size of the batt package for a given amount of batt material or enabling a larger amount of batt material to be included in a package of a given size, while avoiding the above-described damage to the batts caused by the use of flat compression surfaces and, consequently, permitting sufficient recovery of the batt dimensions, and in particular the batt thickness, when the batts are unpackaged.

The expression "compression ratio" as employed herein means the total nominal thickness of the batts, divided by the compressed height of the batts, and the nominal thickness is the thickness which the batts are inclined to assume when released from their package, and which is less than the thickness of the batts prior to the packaging thereof. Also, the "compressed height of the batts" refers to the height of the finished package, if the compression ratio referred to is that of the package, and to the spacing between the flat upper and lower compression surfaces, when the stack is fully compressed therebetween, if the compression ratio referred to is that which is produced by the machine.

As will be apparent from the above description of the fact that the batts expand after leaving the snout, the compressed height of the batts in the package or bag is greater than the compressed height corresponding to the spacing of the compression surfaces when the stack is fully compressed therebetween and, therefore, the compression ratio in the latter case is greater than the package compression ratio.

More particularly, it will be appreciated that the greater the compression of the batts in the machine, the greater will be the damage to the batts. By employing the recessed compression surfaces taught by the present invention, the compression ratio in the machine required to produce a predetermined package compression ratio is less than that required to produce the same predetermined package compression ratio employing flat compression surfaces instead of the presently proposed recessed compression surfaces.

Thus, by forming the upper and lower surfaces of the compressed stack with convex shapes, it is found that the amount of damage caused by the compression of the stack and by the subsequent slight expansion of the stack against its covering bag of plastic material, upon release of the bagged stack from a batt packaging machine, is substantially less, in relation to the package compression ratio, than was possible with the flat compression surfaces utilized in prior art batt packaging machines. Consequently, a higher package compression ratio than was feasible hitherto may be employed.

It is accordingly an object of the present invention to provide a novel and improved apparatus and method for applying a covering to glass fibre batts which enable higher compression ratios than hitherto to be employed for the compression of the glass fibre mats without unduly damaging the mats.

It is a further object of the present invention to employ concave compression surfaces for exerting pressure on the top and bottom of the stack of glass fibre insulation batts to compress the stack in such a way that the top and bottom of the compressed stack conform at least approximately to the convex top and bottom of the finished glass fibre insulation batt package.

It is a still further object of the present invention to enable glass fibre insulation batts to be packaged at a higher rate, and into a more compact package, that has been possible with prior art techniques.

It is a still further object of the present invention to enable a greater compression of a stack of glass fibre insulation batts to be achieved in a single compression operation that has been possible in practice hitherto.

It is another object of the present invention to enable a greater number of glass fibre insulation batts to be compressed into a package of predetermined size than has previously been possible.

It is yet another object of the present invention to enable glass fibre insulation batts to be more highly compressed into a package, without damage to the batts and will still enable an acceptable recovering of the batts from their compressed state upon release from the package, then has been possible hitherto.

It is also an object of the present invention to enable the use of a snout and a ram for driving compressed batts through the snout, and the consequential damage to the batts, which have been common hitherto in the packaging of glass fibre insulation batts, to be avoided.

According to the present invention, there is provided a method of packaging glass fibre insulation batts by compressing a stack of the batts and providing a containment of plastic sheet material around the compressed stack, the improvement comprising the step of employing opposed concave compression surfaces to effect the compression of the stack, whereby the compression of the stack can be substantially enhanced while maintaining satisfactory thickness recovery of the batts upon release from the bag.

The utilization of the concave compression surfaces and the consequential compression of the stack so that the compressed stack has convex upper and lower surfaces enable a larger number of batts to be packaged in a single package, and at a higher throughput rate, then has been possible hitherto.

In this connection, it is particularly pointed out that the use of compression surfaces which are concave results in the compressed shape of the batts between these surfaces being much closer to the shape of the finished package than would be the case if flat compression surfaces were employed for this purpose, as in prior art batt packaging apparatuses. Consequently, for a given size of package, the convex compression surfaces taught by the present invention provide the advantage that they enable more batt material, i.e. a larger number of batts and/or batts of a greater thickness, to be accommodated in the package, than was possible with the prior art flat compression plates previously employed for compressing the batts. This advantage results from the fact that the use of the concave compression surfaces avoids damage to the batts while still allowing satisfactory recovering of the batts from their compressed state when the batts are released from the package, and subject the insulation batts to less damage than is the case, as described above, with the flat compression surfaces utilized in prior art

batt packaging machines. Alternatively, for a given package size the present convex compression surfaces enable a larger number of batts to be accommodated.

While the present method may be employed in conjunction with a snout through which the compressed stack of batts is rounded into a bag, as in the above-described prior art methods and machines, this requires the stack to be compressed by an amount, equal to the thickness of the walls of the snout, which is greater than would otherwise be necessary. It is therefore preferred to avoid the use of a snout by forming the covering around the stack while the stack is compressed between the compression surfaces and then releasing the compressed stack to allow the batts to expand against the covering. This can be achieved by locating upper and lower sheets of flexible material between the stack and the compression surfaces prior to the compression of the stack and sealing together edge portions of these sheets to form the covering while the stack is held in compression by the compression surfaces.

By thus forming the covering around the compressed stack, the shearing scuffing of the compressed stack which previously occurred as it was rammed through the prior art snout are avoided.

The present method also provides the advantage that the above-mentioned second compression of the batts by compressing groups of bags or batt packages into bales, and the consequential substantial damage to the batts which is found to occur in practice during such second compression may be eliminated entirely by simply unitizing batt packages, formed in accordance with the present invention, into bales without compression of the packages.

The present invention further provides, in apparatus for packaging batts of glass fibre material comprising a pair of compression members means for effecting relative displacement of the compression surfaces to compress a stack of glass fiber batts therebetween and means for providing a covering around the compressed stack to retain the batts in a compressed state, the improvement comprising opposed concave surfaces on the compression members for forming correspondingly convex surfaces at opposite ends of the stack during the compression thereof, thereby facilitating compression of the stack counteracting damage to the batts during the compression thereof and promoting satisfactory recovery of the batts upon release from the covering.

The apparatus may include a vertically elongate batt stacking space, means for depositing the batts in succession into the batt stacking space to form the stack of the batts therein, and means for

providing a covering of flexible sheet material around the compressed stack to maintain the stack in a compressed state upon removal of the compressed and covered stack from the apparatus.

Such shaping of the stack counteracts damage to the edges of the uppermost and lowermost batt upon expansion of the stack against its covering, as described above, and thus enables satisfactory recovery of the batts when they are eventually released from their covering and allowed to expand freely.

In a preferred embodiment of the invention, the compression surfaces are cylindrically curved with a radius of curvature of  $1/2W$  to  $3W$ , preferably  $5/8W$ , where  $W$  is the width of the batts. In practice, this radius of curvature is preferably about 9  $1/2$  inches for batts having a width of 15 inches, and about 18 inches for batts having a width of 23 inches.

Although the concave compression surfaces are preferably curved, some advantage over prior art flat compression surfaces may be obtained by forming the compression surfaces with recesses having flat inclined sides and a curved or flat bottom.

However, as will be appreciated from the above discussion, the shapes of the top and bottom surfaces of the compressed stack of insulation batts are preferably formed so as to correspond substantially to the shapes of the corresponding surfaces of the finished package, i.e. of the shape which will be assumed by the compressed batts in their retaining covering when released from the apparatus.

In a preferred embodiment of the invention, a batt support member is mounted for horizontal displacement into and from the batt stacking space at a location near the bottom of the batt stacking space and above the lower compression means. The above support means is withdrawn from the batt stacking space at this location, upon displacement of the batts forward member into the location, in order to transverse the stack of batts from the batt support means to the batt support member.

Upper and lower sheets of covering material are then fed into the batt support space between the top of the stack and the upper compression surface, on one hand, and the batt support member and the lower compression surface, on the other hand, the latter being raised towards the batt support member and the latter then being withdrawn from the batt stacking space to deposit the stack of batts onto the lower sheet on the lower compression surface.

The upper compression surface is then displaced downwardly against the top of the stack to effect the compression of the stack in a single stroke without relaxation, in order to minimize fibre breakage.

When the compression has been completed, edge portions of the covering material sheets are sealed together at opposite sides of the compressed stack.

It will be appreciated, therefore, that the covering is preferably formed around the product in this way, in contrast to prior art techniques, in which the glass fibre insulation batts must be over-compressed and rammed through snouts into prepared bays, both of which operations involve greater damage to the product.

However, depending on the dimensions and compression of the batts, bagging of the batts may in suitable cases be effected by ramming the compressed batts through a snout into bags.

Also in the preferred embodiment of the invention there is employed an auxiliary compression means for compressing the first of the stack in the batt stacking space and for supporting the remainder of the stack for compression of the remainder of the stack by the upper compression means. When the first portion and the remainder of the stack have been equally compressed, the auxiliary compression means is removed from the stack, which is thus united.

The use of this auxiliary compression means enables the overall height of the apparatus to be reduced.

The invention will be more readily understood from the following description of the preferred embodiments thereof given, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 shows a view in perspective of a glass fibre insulation batt compression machine according to a first embodiment of the invention;

Figure 2 shows a view in perspective of an upper batt compression member and associated duct work forming parts of the machine of Figure 1;

Figure 3 shows a view in perspective of a lower batt compression member and associated pneumatic cylinders forming parts of the machine of Figure 1;

Figures 4A through 4I diagrammatically illustrate a sequence of successive stages of operation of the machine of Figure 1 during the formation and covering of a stack of glass fiber insulation batts.

Figure 5 shows a view in perspective of a compressed and covered stack of batts as ejected from the machine of Figure 1 at the end of each cycle of operation thereof;

Figure 6A shows a diagrammatic view in vertical cross-section through a batt compression machine according to a second embodiment of the invention;

Figure 6B shows a diagrammatic side view of the machine of Figure 6A; and

Figure 7 diagrammatically illustrates by way of comparison the compression of batts by flat compression plates and by curved compression plates.

Referring firstly to Figure 1, there is indicated generally by reference numeral 10 a glass fiber insulation batt compression machine according to the first embodiment of the invention. The machine 10 comprises a machine bed indicated generally by reference numeral 11 on which a tower indicated generally by reference numeral 12 is supported and braced by struts 14.

The tower 12 is in the form of a framework of metal beams, comprising four vertical posts 16 which are interconnected by horizontal cross-beams 17, not all of which are shown.

A first platform indicated generally by reference numeral 18 is fixed relative to the tower 12 and carries an upper sheet feed mechanism indicated generally by reference numeral 20 (Figure 4A), which comprises a pneumatic ram 22 carrying, on its piston, gripper jaws 24 for drawing the leading edge of a sheet material 26 from a supply roll 28 and a cutter 25 for cutting transversely across the sheet material 26.

Below the platform 18, the batt packaging machine has a lower sheet feed mechanism indicated generally by reference numeral 30, which comprises a pneumatic ram 32 having jaws 33 for gripping and advancing the leading edge of a sheet material 35 from a supply roll 38 and a cutter 36 for cutting across the sheet material 35 materials. The sheet materials 26 and 35 are polyethylene sheets.

Between the upper and lower sheet feed mechanisms 20 and 30, a carriage indicated generally by reference numeral 39 is moveable vertically along the tower 12.

The carriage 39 carries a pneumatic ram 34, which is operable to effect horizontal displacement of an intermediate compression plate 36. The carriage 39 can be moved to and fro vertically along the tower 12 by a drive mechanism comprising a drive motor 38 connected by a chain and pulley drive transmission indicated generally by reference numeral 40 to the carriage 39.

Between the lower sheet feed mechanism 30 and the carriage 39, a further pneumatic ram 42 is secured to the tower 12 and serves to effect horizontal extension and retraction of a horizontal support plate 44.

At the opposite side of the tower 12, a further carriage, indicated generally by reference numeral 46, is moveable vertically to and fro between an upper position in which it is shown in Figure 4A and a lower position in which it is shown in Figure 4C, by means of a drive motor 48 and a chain and pulley drive transmission indicated generally by

reference numeral 50. The carriage 46 carries a pneumatic ram 52 which is operable to effect horizontal extension and retraction of an upper batt compression member indicated generally by reference numeral 54.

During the downward movement of the carriage 46, as shown in Figures 4A to 4C, with the upper batt compression member 54 extended, the latter travels downwardly through a batt stacking and compression space indicated generally by reference numeral 55.

At the bottom of this compression space 55 there is provided a lower batt compression member 56.

The lower batt compression member 56 is vertically displaceable, through a relatively short distance, from a lowermost position in which it is shown in Figure 4A to an uppermost position in which it is shown in Figure 4E by means of a drive mechanism comprising a drive motor and a chain and pulley mechanism indicated generally by reference numeral 58.

The underside of the upper batt compression member 54 is formed by the cylindrically curved, downwardly concave compression surface of a compression plate 58, and the upper surface of the lower batt compression member 56 is formed by the cylindrically curved, upwardly concave compression surface of a compression plate 60.

The upper batt compression member 54 is a hollow box having opposite flat side walls 55 (Figure 2), formed with suction openings 57a, and having a top surface formed by a plate 62. The interior of this box communicates through a hollow support member 59 and a duct 61 fixed to the hollow support member 59, a gate valve 63a operated by a pneumatic cylinder 63b and a flexible duct 65 with a suction fan 67 to enable air to be sucked in through openings 57b in the compression plate 58.

Above the batt stacking and compression space 55, at the top of the tower 12, there is provided a batt accumulator, indicated generally by reference numeral 64, which serves to accumulate insulation batts delivered thereto by an upwardly inclined conveyor indicated generally by reference numeral 66 in Figure 1 and deposited into the accumulator 64 by a batt loader indicated generally by reference numeral 68.

The accumulator 64 and the batt loader 68 are of conventional construction, which is well known to those skilled in the art, and which therefore will not be described in further detail herein, except to mention that the bottom of the accumulator 64 is provided with a pair of accumulator doors 70 which are pivotable between a closed position, in which they are shown in Figure 4A, and an open position, in which they are shown in Figure 4B, by means of

pneumatic piston and cylinder devices 72. These doors 70, when in their closed position, serve to retain batts in the accumulator 64 and, when opened, release the batts so that the batts are able to fall into the stacking space 55.

The lower batt compression member 56 is in the form of an elongate hollow box which, as shown in Figure 3, is supported at opposite ends on a pair of horizontal lower support beams 71, suspended by vertical bars 73 from upper horizontal support beams 75. A pair of pneumatic cylinders 77, which are mounted on the tower 12, are operable to raise and lower the beams 71 and 73 and, therewith, the lower batt compression member 56.

The shapes of the compression surfaces defined by the upper and lower compression plates 58 and 60 are of particular importance in the operation of the machine and are discussed in greater detail below. For the present, it is simply to be noted that these cylindrically curved concave surfaces substantially correspond in shape to the upper and lower convex surfaces of the insulation batt package to be produced by the machine 10.

The cycle of operation of the machine 10 is as follows.

With the carriage 46 in its uppermost position, and with the pneumatic ram 52 operated to extend the upper batt compression member 54 into its extended uppermost position, in which it is shown in Figure 4A, and in which it underlies the accumulator doors 70 of the accumulator 64, the cycle of operation of the machine is initiated by energizing the motor 48 to displace the carriage 46 downwardly.

The upper batt compression member 54 is correspondingly displaced downwardly through the compression space 55 and, during this downward movement of the upper batt compression member 54, the accumulator doors 70 are opened, as shown in Figure 4B, to deposit glass fiber insulation batts, indicated by reference numeral 74, onto the flat uppermost support plate 62 forming the top of the upper batt compression member 54.

In this way, there is formed on the top plate 62 a first portion of a stack of batts.

The upper batt compression member 54 descends to its lowermost position and, the pneumatic ram 52 is then operated to retract the upper batt compression member 54 and, simultaneously, the pneumatic ram 42 is operated to extend the support plate 44 horizontally into the stacking space 54 below the batts therein, so that the first portion of the stack of batts is thereby transferred from the top plate 62 of the upper batt compression member 54 to the top of the support plate 44, as illustrated in Figure 4C.

The carriage 46 is then displaced upwardly, as shown in Figure 4D, to return to its uppermost position, as shown in Figure 4E.

Meanwhile, the carriage 32 is raised by the motor 38 to the level of the top of the stacking space 55, the pneumatic ram 34 is operated to extend the intermediate compression plate 36 into the stacking space 55 and the accumulator doors 70 open to deposit additional batts onto the intermediate compression plate 36, as also shown in Figure 4D, the motor 38 being energized to cause the carriage 32 and therewith the intermediate compression plate 36 to be displaced downwardly.

Consequently, the first portion of the stack of batts is compressed between the intermediate compression plate 36 and the support plate 44, as shown in Figure 4E.

As also shown in Figure 4E, the accumulator doors 70 are again closed and the pneumatic ram 32 is operated as indicated by an arrow, to advance the sheet material 35 across the compression space 55 between the extended support plate 44 and the lower batt compression member 56 and the cutter 26 is operated to provide a cut lower sheet 37 on the lower compression plate 60.

Also, the lower batt compression member 56 is raised by operation of the pneumatic cylinders 77 from its lowermost position to its uppermost position, in which it more closely underlies the support plate 44, so as to minimize the distance between the bottom of the compressed batts and the compression surface of the lower compression member 56 and, thus, to counteract a misalignment of the compressed batts as the support plate 44 is retracted into its withdrawn position, in which it is shown in Figure 4F, to allow the compressed batts to expand downwardly onto the lower batt compression member 56.

While the support plate 44 remains in its extended position and in order to avoid excessive compression of the batts between the support plate 44 and the intermediate compression plate 36, the latter is moved downwardly through no more than two thirds of its path of travel.

When sufficient additional batts to form a second portion of the stack which is to be compressed into a single package has been fully accumulated on the intermediate compression member 36, the pneumatic ram 22 is operated to extend the gripper jaws 24 across the stacking space 55 and, the cutter 25 is operated to provide an upper cut sheet 41 of flexible material between the uppermost batt in the stacking space 55 and the underside of the upper batt compression member 54, which is again extended into the top of the stacking space 55 by operation of the pneumatic ram 52 as shown in Figure 4F.

Also the lower batt compression member 56 is lowered from its uppermost position, in which it is shown in Figure 4E, to an intermediate position, in which it is supported by lock bars 180 as shown in Figure 4F.

By the application of suction from the interior of the upper batt compression member 54 through the openings 57b in the compression plate 58, the upper cut sheet 41 of material, which at this time is released by the gripper jaws 24, is drawn against the curved downwardly facing surface of the compression plate 58 and thereby retained against that surface while opposite edge portions of the sheet 41 are retained against the side walls 55 by suction through the openings 57a.

The pneumatic ram 22 is then operated to retract the gripper jaws 24 from the stacking space 55, and the motor 48 is operated to cause the carriage 46 to descend and, thus, to cause the upper batt compression member 54 to descend through the batt stacking space 55.

When the compression of the batts between the intermediate plate 36 and the lower batt compression member 56 is substantially equal to that of the batts between the intermediate plate 36 and the upper batt compression member 54, the pneumatic ram 34 is operated to retract the intermediate compression plate 36, as shown in Figure 4G, so that the batts between the upper and lower batt compression members 54 and 56 are united into a single stack with the lower batt compression member 56 still in its intermediate position.

The upper batt compression member 54 continues to descend until it reaches its lowermost position, as shown in Figure 4H, and the lower batt compression member 56 is moved upwardly, until the compression of the batts has been completed.

Heat seal bars 78 at opposite sides of the compressed stack of batts are then operated to clamp together and to seal together marginal edge portions of the upper and lower sheets of packaging material to form a covering around the compressed stack of batts.

The upper batt compression member 54 is then raised and the lock bars 180 are withdrawn from the lower batt compression member 56, which is lowered into its lowermost position, in which it is shown in Figure 4I, in order to release the pressure exerted thereby on the stack of batts. Consequently, the batts are thereby allowed to expand within their covering by an amount which is restricted by the covering, so that the batts are then maintained in a state of compression by the covering.



The compressed and covered stack of batts, which is indicated generally by reference numeral 80 in Figure 5, is then ejected from the machine 10 by the operation of a ram 181 perpendicular to the plane of Figures 4A to 4H, and the next cycle of the operation of the machine, starting from the state shown in Figure 4C, is initiated.

As can be seen from Figure 5, the compressed stack of batts, indicated by reference numeral 82, is retained in its compressed state by the elongate seals, one of which is shown and indicated by reference numeral 84, connecting together the marginal edge portions of the upper and lower cut sheets 37 and 41 of packaging material, which project beyond opposite ends of the stack to form free end portions 86.

These free end portions 86 of the cut sheets 37 and 41 are collapsed and sealed at the opposite ends of the stack in a separate operation (not shown) to provide a sealed bag enclosing the stack.

By compressing initially a first portion of the total batt content of a package and then subsequently compressing the remainder of the batts to be included in the same package, the height of the stacking space 55, and thus the height of the tower 12, can be reduced as compared to what would be required to compress the entire stack of batts in a single stroke of the upper batt compression member 54.

Figures 6A and 6B diagrammatically illustrate a modification of the machine of Figure 10.

As shown in Figure 6A, the modified machine has, instead of a single upper batt compression member 54, two upper batt compression members, indicated by reference numerals 154a and 154b, respectively, which are displaceable to and from the stacking space 55 by respective pneumatic cylinders 152a and 152b, mounted on carriages indicated generally by reference numerals 146a and 146b, respectively. The carriages 146a and 146b are displaceable to and fro vertically by chain and sprocket drive transmissions indicated generally by reference numerals 140a and 140b, driven by respective motors (not shown).

Upper and lower sheet feed mechanisms 120a and 130a are, in this case, arranged to feed the sheet material along the length of the upper and lower compression members, rather than transversely, i.e. in the direction of their widths as is the case with the machine 10 of Figures 1 and 2.

Also, a support plate 136 is displaceable to and fro by means of a pneumatic ram 134 in the same direction as the sheet material, i.e. longitudinally of the upper and lower batt compression members.

Thus, the upper and lower sheet feed mechanisms 120a and 130a and the support plate 136 do not obstruct the vertical displacement of the carriages 146a and 146b.

Also, the upper and lower batt compression members 154a and 154b are each provided with an auxiliary support plate 155a and 155b, respectively, which are each spaced above the upper batt compression members 154a and 154b by a gap which, in the case of the support plate 155a is laterally open to the left as viewed in Figure 4A and, in the case of the support plate 155b is open to the right, also as shown in Figure 4A, to accommodate the support plate 136 and to allow the upper batt compression members 154a and 154b to be extended into and retracted from the stacking space 55 while the upper plate 136 is in its extended position, i.e. while the support plate 136 is extended into the stacking space 55.

For convenience of illustration, a pneumatic ram 158 has been shown in Figures 4A and 4B for raising and lowering the lower batt compression member 156.

Also, Figures 4A and 4B show a ram 182 which can be extended and retracted longitudinally of the batt compression members for ejecting the batt packages from this machine. It will be appreciated that other types of drives, e.g. chain and sprocket drives, may be utilized instead of the rams 158 and 182.

The modified machine further incorporates a batt accumulator indicated generally by reference numeral 164, which like the batt accumulator 64 of Figures 1 and 2 is of conventional construction, and sealing jaws 178 corresponding to the sealing jaws 78 of the machine 10.

In operation of this modified machine, batts are released by the batt accumulator 164 to fall into the stacking space 55 and, thereby, to form stacks on the uppermost surfaces of the supports 155a and 155b, as the upper batt compression members 154a and 154b are moved in succession downwardly through the stacking space 55.

When the upper batt compression member 154a reaches its lowermost position, the support plate 136 is extended into the gap beneath the support plate 155a, and the upper compression member 154a is then withdrawn laterally from the stacking space 55 to transfer its load of batts from the batt support plate 155a to the support plate 136.

The lower batt compression member 156 is then raised by operation of the pneumatic ram 158 to receive these batts from the support plate 136 upon retraction of the latter from the stacking space 55, and the lower batt compression member 156, now supporting thereon the above-mentioned stack of batts, is again lowered by operation of the pneumatic ram 158 into its lowermost position.

Prior to the withdrawal or retraction of the support plate 136, the lower sheet feed and cutting mechanism 130a is operated to provide a sheet of packaging material on the lower batt compression member 156.

The upper compression member 154b is then extended into the top of the stacking space 55, and the upper sheet feed and cutting mechanism 120a is operated to feed an upper sheet of material between the upper batt compression member 154b and the underlying stack of batts.

The upper batt compression member 154b is then caused to descend through the stacking space 155, thus compressing this stack of batts against the lower batt compression member 158. When this compression has been completed, the sealing jaws 178 are operated to seal together the marginal edge portions of the upper and lower sheets of packaging material, thus packaging the compressed batts, the lower batt compression member 154b is raised slightly to release the package and the ram 180 is extended to eject the package from the machine.

During its above-mentioned descent through the stacking space 55, the upper batt compression member 154b accumulates a second stack of batts on its support plate 155b. This second stack is then subsequently compressed in a like manner between the lower batt compression member 156 and the upper batt compression member 154a in a manner which will be readily apparent from the above description.

It will be apparent that the upper batt compression members 154a and 154b and the lower batt compression member 156 have concavely curved compression surfaces and, as will be readily apparent from the preceding description, the purpose of such curvature is to compress the stacks of batts in such a manner that upper and lower faces of the compressed stacks have convex shapes correspondingly at least approximately to the eventual shapes of the top and bottom of the package upon release of the package by the compression surfaces.

As described in some detail hereinabove, the advantages of the use of concavely curved compression surfaces, as in the machine 10 of Figures 1 and 2 and the modified machine of Figure 3, over the use of flat compression plates as employed in the prior art include the possibility of employing a greater compression ratio, reduced damage to the batts, a more compact packaging and improved batt recovery at high compression ratios, in addition to increased throughput and the avoidance of unduly high machine operating speeds.

In this connection, reference is made to Figure 4, which illustrates the results of an experimental comparison of the use of flat and curved plates for producing a batt package of a predetermined size.

More particularly, both types of plates were employed to produce a batt package, illustrated at the middle in Figure 4, having a height of 18 inches and containing batts under compression with a package compression ratio of 6.8:1.

As shown to the left of Figure 4, it is found in practice that, when employing flat plates to produce such a package, a compression ratio of 10.3:1 is required, the batts being compressed to a height of 11.7 inches.

On the other hand, employing curved plates, as illustrated at the right in Figure 4, it was necessary to employ a compression ratio of only 7.9:1, and to compress the batts to a height of 15.3 inches at the centers of the batts, in order to produce the same package.

To minimize damage to the batts, the shapes of the compression plates should permit the minimum of distortion between the compressed shape of the stack of batts and the eventual package shape. Thus, the curvature of the plates should be substantially similar, in a complimentary manner, to the shape of the finished package.

However, to allow for some stretch in the sheet material employed for the packaging, a certain amount of over-compression of the stack of batts is required in practice, and the shapes of the compression surfaces must allow for such over-compression. Consequently, the depth of each compression surface profile should be less than 1/2 of the height of the compressed shape.

For example, if it is desired to produce packages having a height of 14.6 inches, then it is found that a radius of curvature of 9 1/2 inches for the compression surfaces is suitable for batts having a width of 15 inches and 16 inches. However, an "ideal" radius of curvature of 15 inches for use with batts having a width of 23 inches and 24 inches would not permit sufficient compression to achieve a package height of 14.7 inches and, accordingly, wider compression surfaces employed for such wider batts are preferably flattened somewhat to a radius of a curvature of approximately 18 inches.

In general, the inventor has found that the shape of the compression surfaces should be that which most closely fits the curved surfaces of the finished package and which, nevertheless, permits the compression surfaces to be moved together sufficiently to provide the required amount of over-compression of the batts.

It is not essential for the compression surfaces to be cylindrically curved. Thus, for example, the compression surfaces may be curved surfaces having different radii of curvature at different points

across the surfaces, and it has been found that, whether cylindrically curved or otherwise curved, the radius of curvature of the compression surfaces should not be less than  $1/2W$  where  $W$  is the width of the batts, nor more than  $3W$ , and that preferably the radius of curvature should be  $5/8W$ .

Furthermore, the invention is not restricted to the use of compression surfaces having curved recesses therein but may be performed, for example, employing concave compression surfaces which are recessed with the shape comprising flat inclined side walls extending to a flat or curved bottom or curved side walls extending to a flat bottom, provided that the shape of the recess approximates the shape of the top and bottom of the finished batt package, as discussed above.

### Claims

1. A method of packaging glass fibre insulation batts by compressing a stack of the batts and providing a containment of plastic sheet material around the compressed stack, characterized in that opposed concave compression surfaces are employed to effect the compression of the stack (80), whereby the compression of the stack (80) can be substantially enhanced while maintaining satisfactory thickness recovery of the batts (74) upon release from the containment.

2. A method as claimed in Claim 1, characterized in that the containment is provided by locating separate sheets (37, 41) of the plastic material between the stack (80) and the compression surfaces prior to the compression of the stack (80) and sealing the sheets (37, 41) together at opposite longitudinal sides of the stack (80) after the compression of the stack (80).

3. A method of packaging glass fibre insulation batts by compressing a stack of the batts between opposed compression surfaces and providing a covering around the compressed batts to retain the batts in a compressed state, characterized in that plastic sheet material (37, 41) is inserted between the stack (80) and each of the compression surfaces prior to the compression of the stack (80) and portions of the plastic sheet material (37, 41) are joined at opposite sides of the stack, subsequent to the compression of the stack, to retain the stack (80) in a compressed state.

4. A method as claimed in Claim 3, characterized by locating separate sheets (37, 41) of the plastic sheet material between the stack (80) and respective ones of the compression surfaces prior to the compression of the stack, and sealing together marginal edge portions of the sheets (37, 41) subsequent to the compression of the stack.

5. A method as claimed in Claim 1, 2, 3 or 4 characterized in that the compression of the stack (80) is effected with a compression ratio of from 2.5:1 to 12:1.

6. A method as claimed in any preceding claim, characterized in that the compression of the stack (80) is effected with a compression ratio of 6:1 to 11:1.

7. A method as claimed in any preceding claim, characterized in that upper and lower surfaces of the stack (80) are formed into convexly curved shapes during the compression of the stack.

8. A method as claimed in Claim 7, characterized in that the convexly curved shapes each have a radius of curvature in the range of  $W/2$  to  $3W$ , where  $W$  is the width of the batts.

9. A method as claimed in Claim 7, characterized in that the convexly curved shapes each have a radius of curvature of approximately  $5/8W$ , where  $W$  is the width of the batts.

10. A method as claimed in Claims 1 to 9 including: supplying the batts in succession to the top of a vertically elongate batt stacking space; forming the stack of the batts in the space; supporting the stack on a lower one of the compression surfaces; locating an upper one of the compression surfaces above the stack; and compressing the stack between the upper and lower compression surfaces by relative vertical displacement of the upper and lower compression surfaces, characterized in that the concave shapes of the upper and lower compression surfaces are thereby used to form the compressed stack (80) with convex upper and lower stack surfaces which are at least substantially similar in shape to corresponding convex upper and lower surfaces of the package to facilitate compression of the stack (80) and to promote satisfactory recovery of the batts upon release from the package.

11. A method as claimed in any preceding claim, characterized by applying suction to an upper sheet (37) of the sheet material (37, 41) to retain the upper sheet against the upper compression surface prior to the compression of the stack.

12. A method as claimed in any preceding claim characterized by supporting the batts on a first support surface (62) during the assembly of the batts into the stack;

lowering the first support surface (62) into a predetermined position spaced above a lower one of the surfaces;

withdrawing the first support surface (62) laterally from beneath the batts and simultaneously displacing a second support surface (44) horizontally beneath the batts; and

subsequently withdrawing the second support surface to thereby deposit the batts onto the sheet material (37, 41).

13. A method as claimed in Claim 12, characterized by displacing the lower compression surface upwardly; subsequently introducing the sheet material (37, 41) between the lower compression surface and the batts; and thereafter lowering the lower compression surface with the batts supported thereon prior to the compression of the stack (80).

14. A method as claimed in any of claims I to II, characterized by displacing a pair of downwardly concave upper compression surfaces downwardly in succession to compress respective stacks of batts against a lower one of the compression surfaces, providing upper and lower sheets (37, 41) of the plastic sheet material (37, 41) on each of the stacks and sealing edge portions of respective ones of the upper and lower sheets (37, 41) to provide a retaining covering around each of the compressed stacks.

15. Apparatus for forming a package of batts of glass fibre material comprising a pair of compression surfaces, means for effecting relative displacement of the compression surfaces to compress a stack of glass fiber batts therebetween and means for providing a covering around the compressed stack to retain the batts in a compressed state, characterized by opposed concave surfaces on the compression members (20) for forming correspondingly convex surfaces at opposite ends of the stack (80) during the compression thereof, thereby facilitating compression of the stack (80), counteracting damage to the batts during the compression thereof and promoting satisfactory recovery of the batts upon release from the covering.

16. Apparatus as claimed in Claim 15, characterized in that the means for providing a covering comprise means (20, 30) for disposing sheets (37, 41) of plastic material between the stack (80) and respective ones of the compression members (54, 50) before the compression of the stack (80) and means for sealing together marginal edge portions of the sheets (37, 41) after the compression of the stack (80).

17. Apparatus for forming a package of glass fibre batts, comprising a pair of compression members for compressing a stack of the batts and means for applying to the compressed stack a covering which retains the stack in its compressed state, characterized in that the covering applying means comprises means (20, 30) for inserting sheets (37, 41) of plastic material between the stack (80) and respective ones of the compression members (54, 56) prior to compression of the stack (80) and means (78) for sealing together marginal

edge portions of the sheets (37, 41) at opposite sides of the stack (80) after the compression of the stack (80).

18. Apparatus as claimed in Claim 15, 16 or 17, characterized in that the compression surfaces are concavely curved surfaces.

19. Apparatus as claimed in Claim 15, 16 or 17, characterized in that the compression surfaces are curved surfaces having a curvature of  $W/2$  to  $3W$ , where  $W$  is the width of the batts.

20. Apparatus as claimed in Claim 15, 16 or 17, characterized in that the compression surfaces are curved surfaces having a curvature of approximately  $5/8W$ .

21. Apparatus as claimed in Claim 15, 16 or 17, characterized in that the compression surfaces are cylindrically curved and each have a radius of curvature lying within the range  $1/2W$  to  $3W$ , where  $W$  is the width of the insulation batts.

22. Apparatus as claimed in Claim 21, characterized in that the circular curvature is approximately  $5/8W$ .

23. Apparatus as claimed in any one of Claims 15 to 22 having a vertically elongate batt stacking space; means for depositing the batts in succession into the batt stacking space to form a stack of the batts therein; and upper and lower compression means for effecting vertical compression of the stack of batts in the batt stacking space; characterized in that the compression surfaces are provided on the upper and lower compression means (54, 56) and have concave compression surfaces the shapes of which correspond at least substantially to the shapes of convex upper and lower surfaces of the package.

24. Apparatus as claimed in any one of Claims 15 to 23, characterized by auxiliary compression means (39) for compressing a first portion of the stack (80) and supporting the remainder of the stack (80) during compression thereof by the compression surfaces, and means (34) for withdrawing the auxiliary compression means (34) horizontally outwardly from between the compressed first portion and the remainder of the stack (80) to unite the stack.

25. Apparatus as claimed in any one of Claims 15 to 24, characterized by a pair of upper compression members (154a, 154b) displaceable downwardly in succession for compressing respective successive stacks of the batts, the compression members (154a, 154b) each having a downwardly concave compression surface.

26. Apparatus as claimed in any one of Claims 15 to 25, characterized in that the compression surfaces are upper and lower surfaces and the lower surface is displaceable upwardly into a raised position for receiving the stack (80) and into a lower position for compression of the stack.

27. A glass fibre batt package, comprising a plurality of glass fibre batts arranged in a stack and a covering of plastic sheet material extending around the stack and maintaining the stack in a compressed condition, characterised in that the stack (80) of glass fibre batts is compressed with a compression ratio of from 2.5:1 to 12:1. 5

28. A glass fibre batt package as claimed in Claim 27, characterized in that the stack (80) has a compression ratio of from 6:1 to 11:1. 10

29. A glass fibre batt package as claimed in Claim 27 or 28, characterized in that the covering comprises a pair of sheets (37, 41) of the plastic material, the sheets (37, 41) being joined together along marginal edge portions thereof at opposite sides of the stack (80) to form laterally outwardly extending longitudinal flaps. 15

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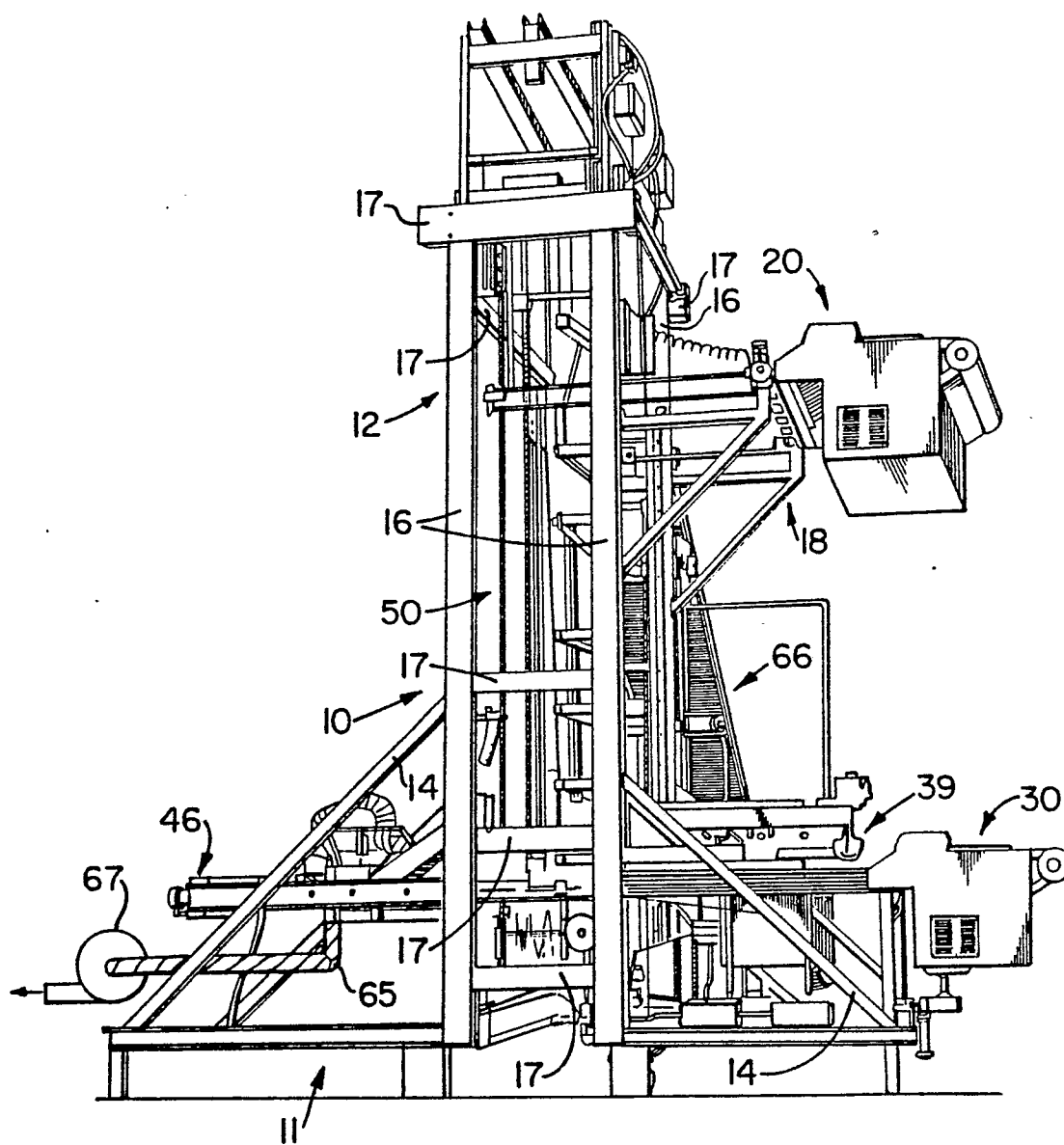


FIG. 1

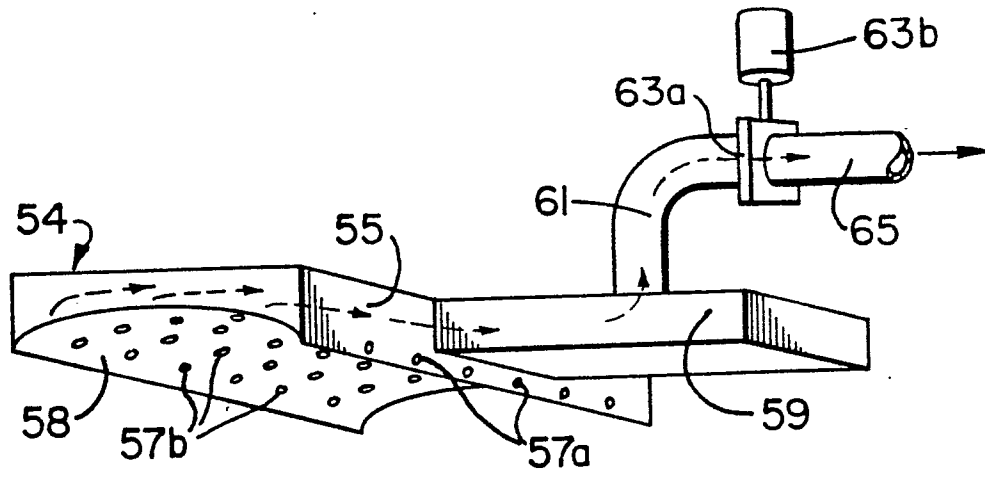


FIG. 2

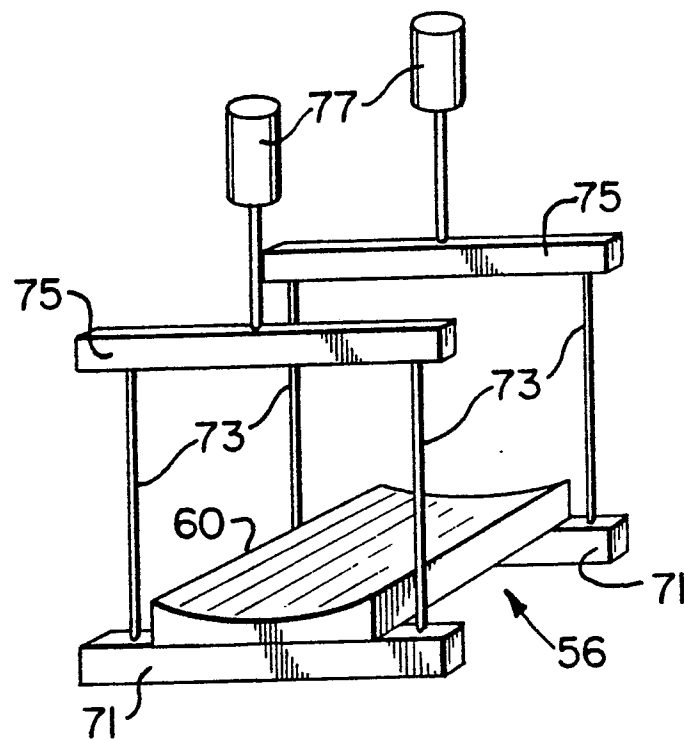


FIG. 3

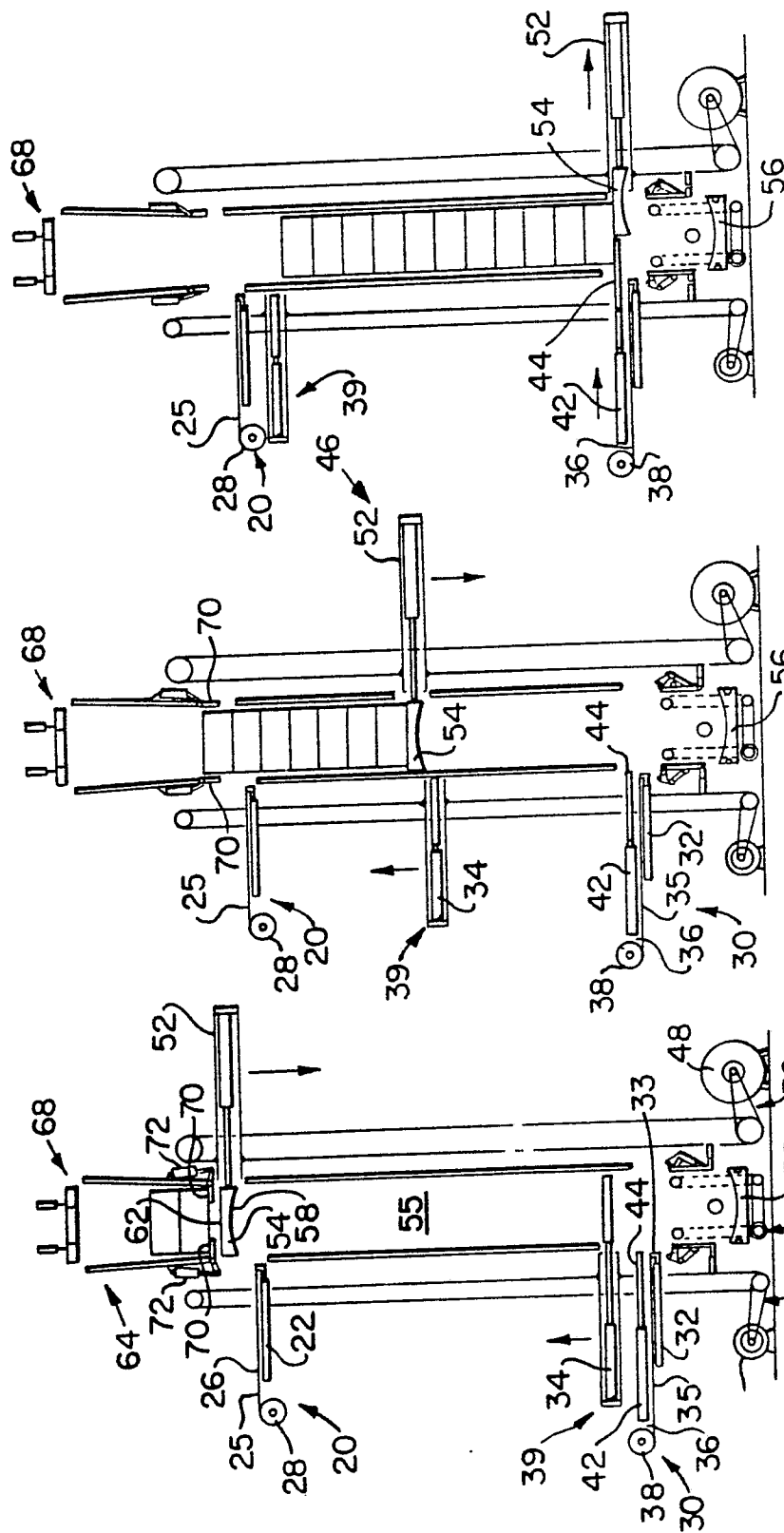


FIG. 4C

FIG. 4B

FIG. 4A



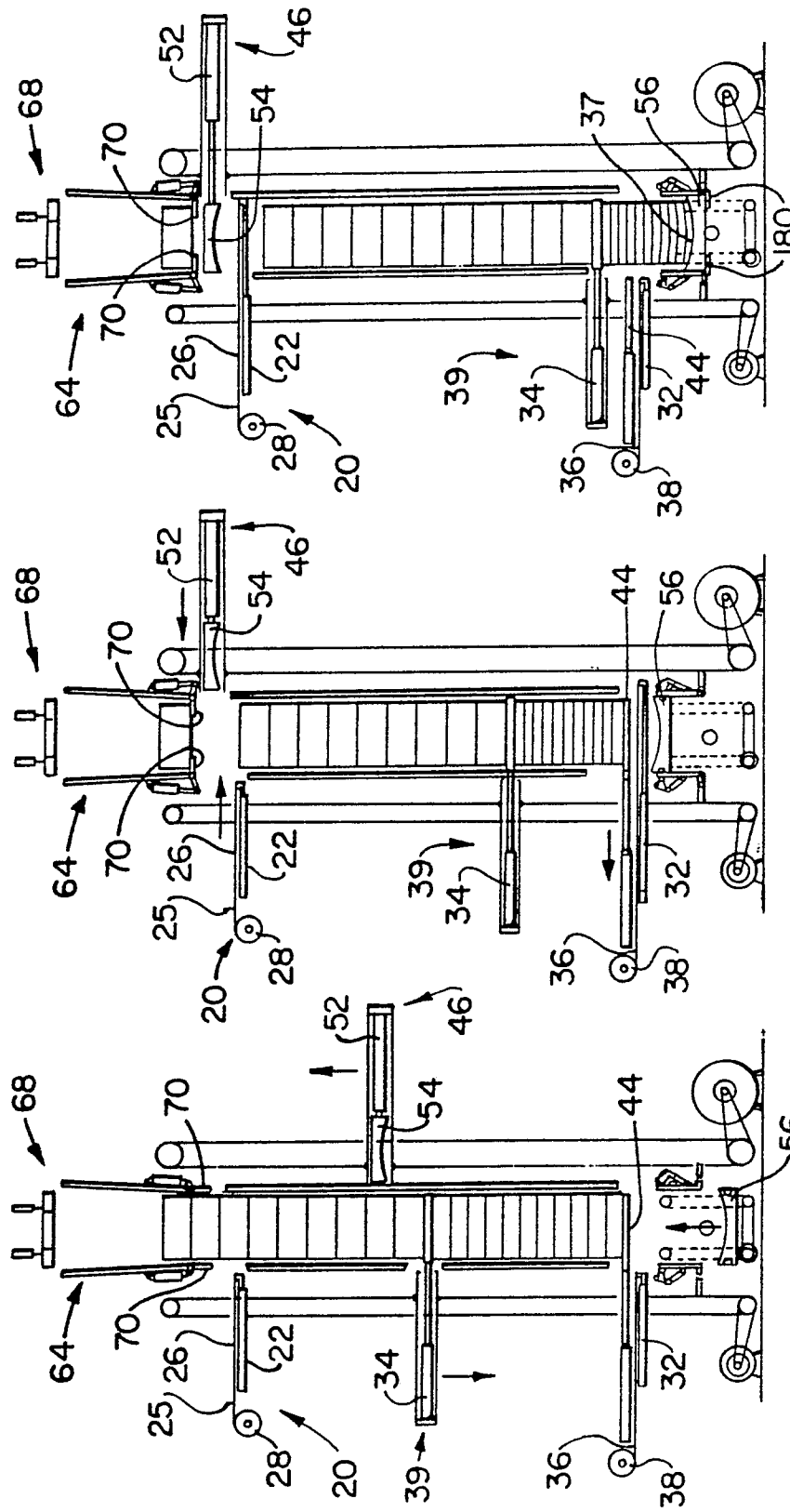


FIG. 4D

FIG. 4E

FIG. 4F

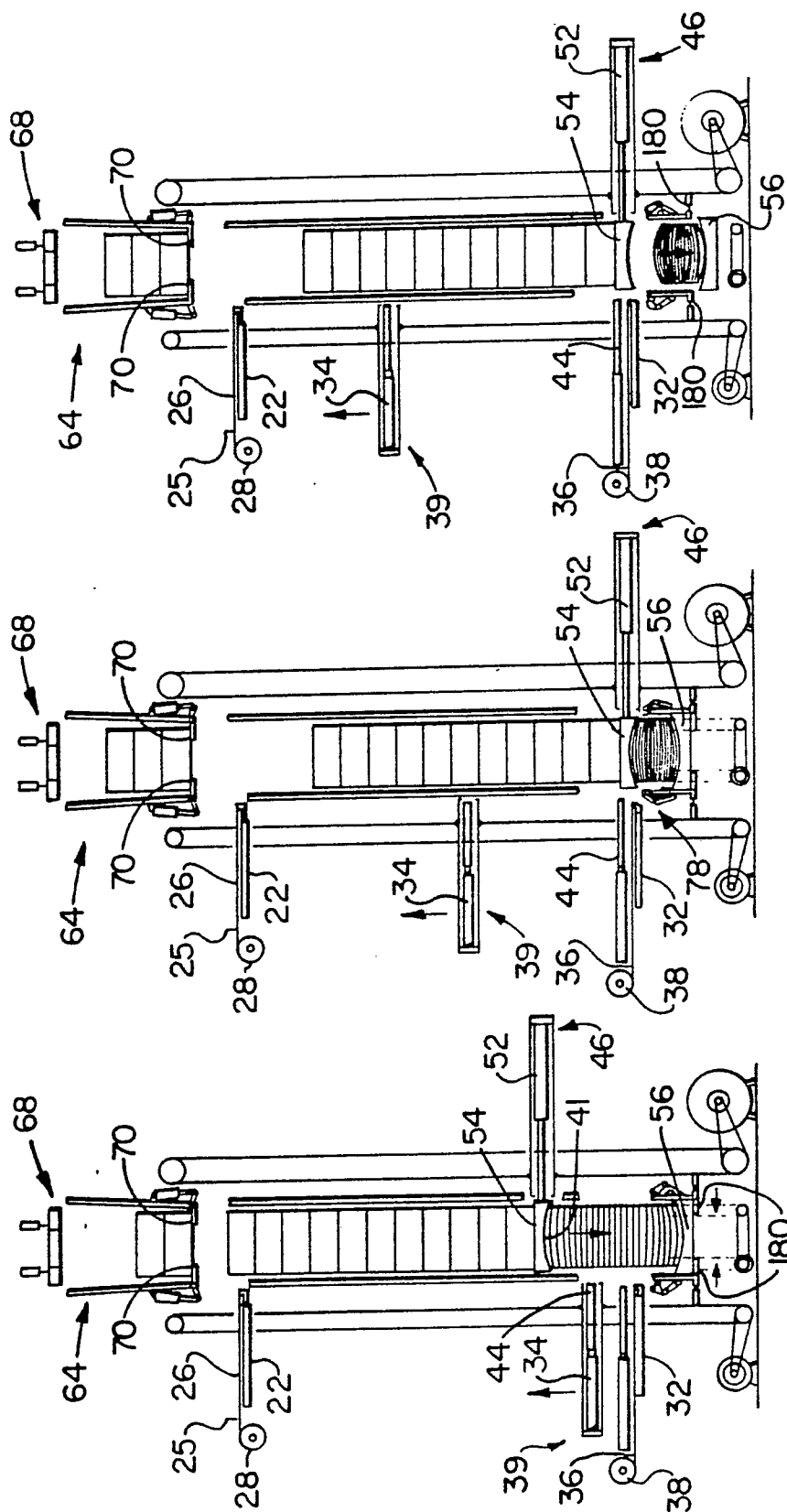


FIG. 4G

FIG. 4H

FIG. 4I

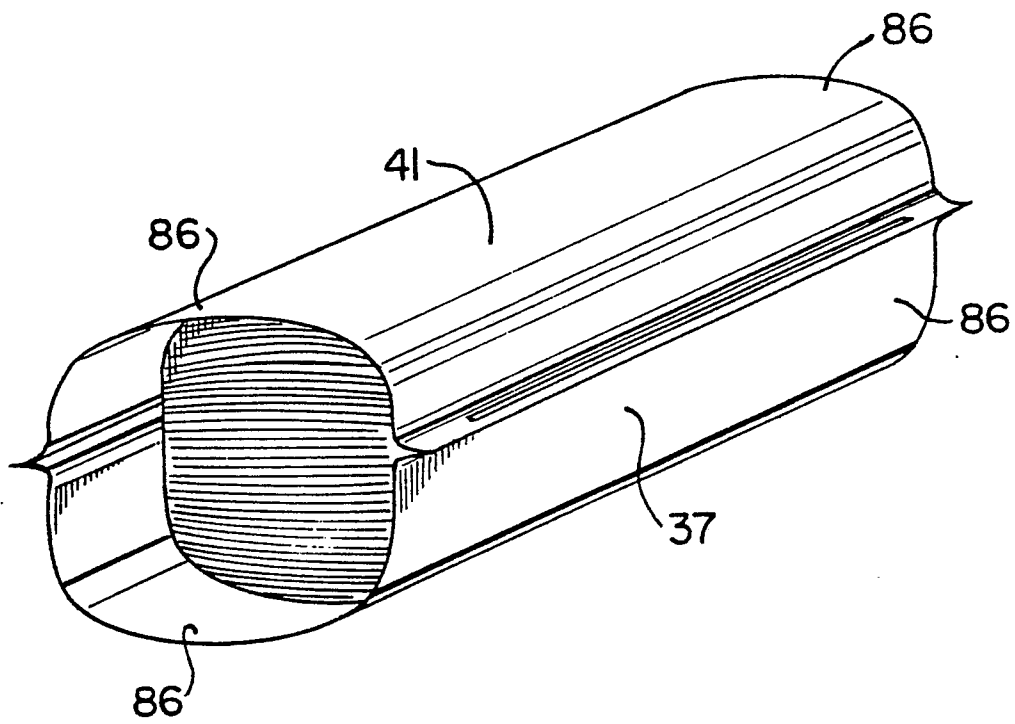
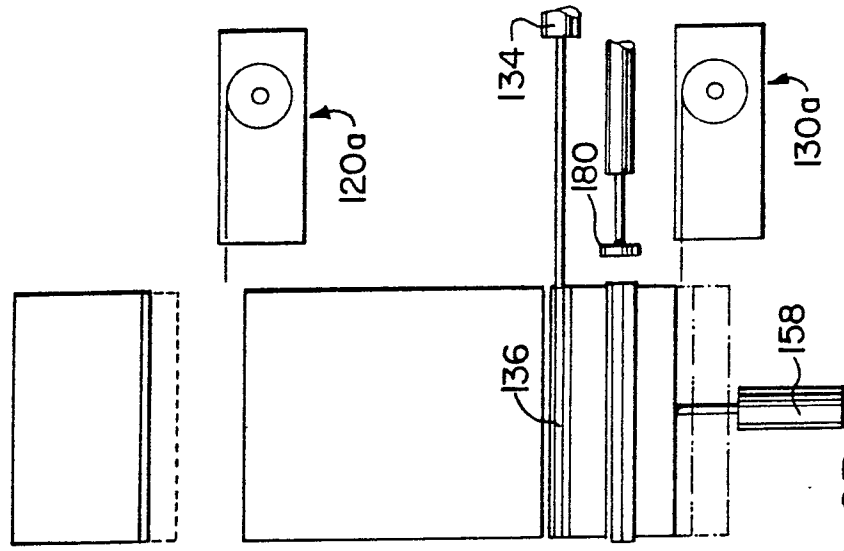
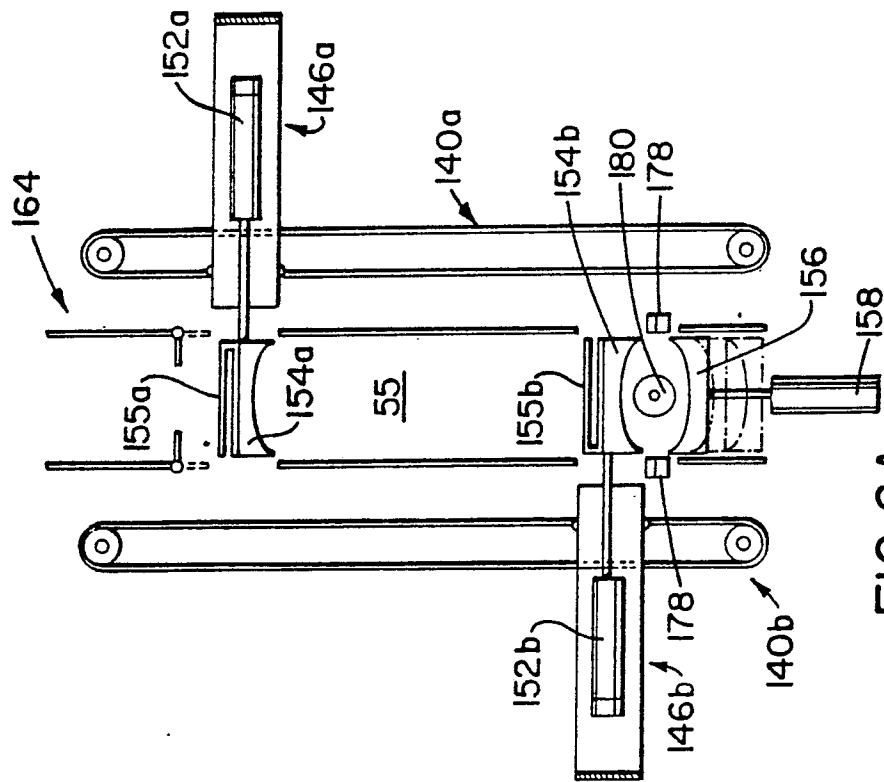


FIG. 5



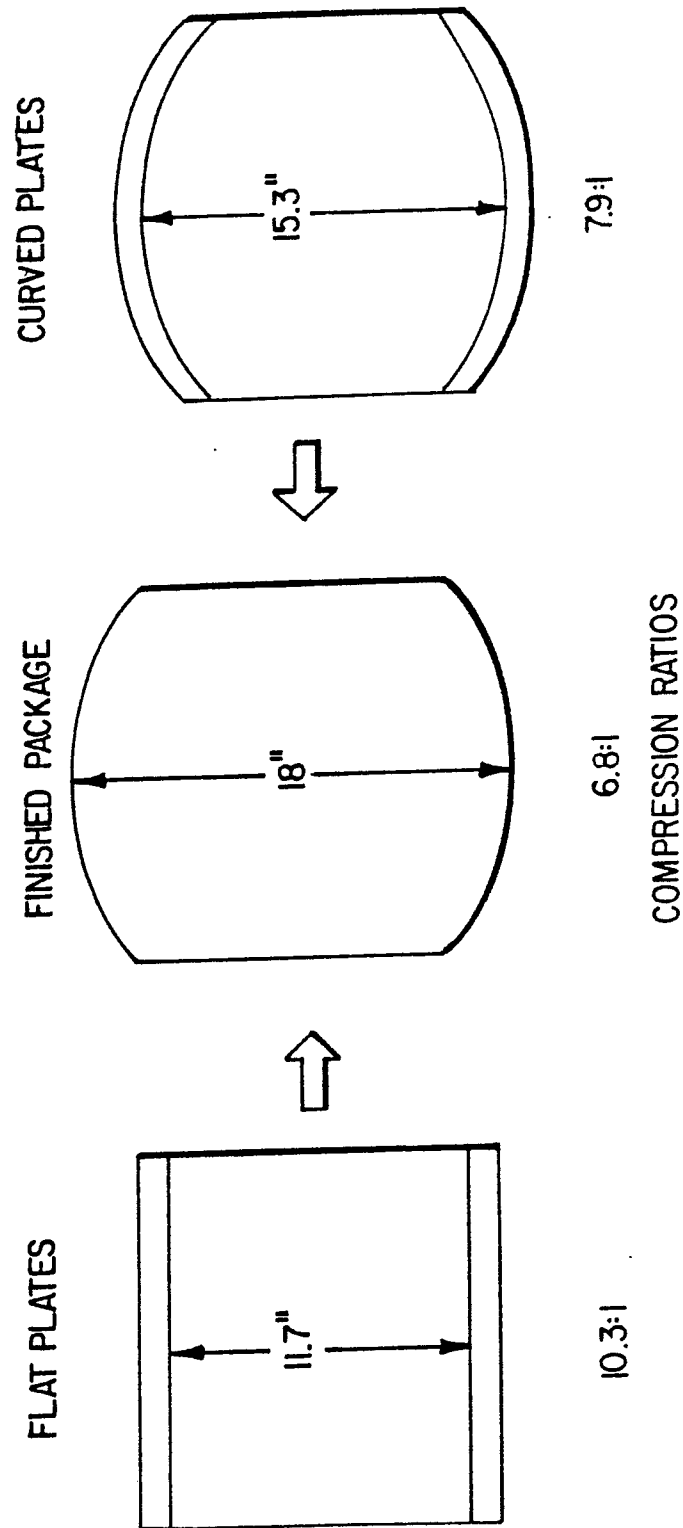


FIG. 7



| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                     |                                                                                                     |                                                                                                                                                                                                                                                                                  |                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|
| Category                                                                                                                                                                                                                | Citation of document with indication, where appropriate, of relevant passages                       | Relevant to claim                                                                                                                                                                                                                                                                | CLASSIFICATION OF THE APPLICATION (Int. Cl.4) |
| X                                                                                                                                                                                                                       | EP-A-0 142 438 (CERTAIN TEED CORP.)<br><br>* Page 10, line 16 - page 11, line 29; figures 1,4,6,7 * | 1,7,10<br>,15,18<br>,23,25                                                                                                                                                                                                                                                       | B 65 B 63/02                                  |
| Y                                                                                                                                                                                                                       |                                                                                                     | 2-5,14<br>,16,17<br>,27,29                                                                                                                                                                                                                                                       |                                               |
| Y                                                                                                                                                                                                                       | CH-A- 458 189 (SAINT-GOBAIN)<br><br>* Column 4, lines 3-34; figures *<br><br>-----                  | 2-5,14<br>,16,17<br>,27,29                                                                                                                                                                                                                                                       |                                               |
|                                                                                                                                                                                                                         |                                                                                                     |                                                                                                                                                                                                                                                                                  | TECHNICAL FIELDS SEARCHED (Int. Cl.4)         |
|                                                                                                                                                                                                                         |                                                                                                     |                                                                                                                                                                                                                                                                                  | B 65 B                                        |
| The present search report has been drawn up for all claims                                                                                                                                                              |                                                                                                     |                                                                                                                                                                                                                                                                                  |                                               |
| Place of search<br>THE HAGUE                                                                                                                                                                                            |                                                                                                     | Date of completion of the search<br>14-09-1987                                                                                                                                                                                                                                   | Examiner<br>JAGUSIAK A.H.G.                   |
| <b>CATEGORY OF CITED DOCUMENTS</b>                                                                                                                                                                                      |                                                                                                     |                                                                                                                                                                                                                                                                                  |                                               |
| X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document |                                                                                                     | T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br><br>& : member of the same patent family, corresponding document |                                               |